Lower San Juan Basin Groundwater Yield Enhancement Study

Project Description

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Introduction and Groundwater Management Planning

MWDOC in cooperation with the San Juan Basin Authority (SJBA) is submitting this grant application for funding to conduct an investigation for the main purpose of increasing groundwater recovery in the Lower San Juan Basin and for integration of the planned South Orange Coastal Ocean Desalination (SOCOD) Project, which is planned to utilize a slant well field along the coast to provide feedwater to the project as well as salvaging groundwater outflow losses to the ocean and to provide an effective seawater intrusion control barrier.

SJBA previously prepared and adopted the San Juan Basin Groundwater Management and Facility Plan (GWMP) in 1994. SJBA is now in the process of updating the GWMP which is scheduled to be completed later this year. The SJBA authorized the update of the GWMP at its August 24, 2010 meeting and awarded the work to Wildermuth Environmental, Inc. This work is nearing completion. The following table provides a summary of the scope and status of the GWMP.

San Juan Basin Groundwater Management and Facility Plan Status
July 2, 2013

Task	Description	Percent Complete
1	Define Water Management Objectives	100
2	Describe Planning Area and its Resources	100
3	Describe Historical and Future Water Requirements	100
4	Describe Existing Resources	95
5	Reserved	
6	Define Alternative Management Plans	30
7	Evaluate Alternative Management Plans	0
8	Describe Recommended Management Plan	0
9	Develop Monitoring and Reporting Protocols	0
10	Prepare Groundwater Management Plan Report	25
11	Project Meetings and Coordination	
12	Preliminary CEQA Analysis	0
13	Project Management	

This work is scheduled to be completed and adopted by the end of this year.

As part of development work for the SOCOD Project, which just completed an 18-month extended pumping and pilot plant test on a Test Slant Well, an updated surface/groundwater flow and solute transport model is also in the process of being

developed to support the SJBA GWMP work and SOCOD Project impact evaluation. The groundwater model will be utilized in this study to quantify streamflow yields of basin improvement projects to be evaluated in the study.

Overall Objective

The overall objective for this study is to evaluate feasible means to increase brackish/saline groundwater recovery and supply from the Lower San Juan Basin. This work will build off substantial work and progress made to date in the Lower San Juan Basin over the past several years.

The expected outcome from the studies to be undertaken described in this grant application, will be to determine the feasibility for expanded utilization of the basin and for increased conservation of stormwater and present an implementation plan.

SJBA agencies are looking to expand their existing groundwater recovery plants to pump up to their water rights and MWDOC and its participants are looking to move forward with the implementation of the SOCOD Project, which will require an agreement with SJBA on salvage of groundwater losses and water rights, and mitigation for any significant drawdown impacts. MWDOC also needs to work with the regulatory agencies to gain a better understanding of potential impacts and mitigation approaches for the SOCOD Project due to groundwater drawdown.

MWDOC

The Municipal Water District of Orange County (MWDOC) was organized and formed in 1951 and is the third largest member agency of Metropolitan Water District of Southern California. Since that time, MWDOC has facilitated the development of the imported water delivery system into its service area. The delivery pipelines that serve south Orange County are joint ownership lines in which MWDOC took the lead in their planning and implementation with Metropolitan

Water District and the south Orange County agencies. The first major pipeline constructed to serve the area was the East Orange County Feeder No. 2 and two regional locally owned transmission lines in the early 1960's. These pipelines convey treated imported water from the Diemer Treatment Plant located in Yorba Linda.

The Santiago Aqueduct, now known as the Baker Aqueduct conveys untreated water from the Lower Feeder System from Lake Mathews to the Lake Forest area; the untreated water system was never extended to the San Juan Basin. Subsequently, the Allen McColloch Pipeline was constructed in early 1980's to augment treated water supply to the south Orange County area. Demand in this area is projected by the local agencies to increase from a current demand level of approximately 100,000 afy to 115,000 afy by 2020 with the build-out of approved development plans.

San Juan Basin Authority (SJBA)

The San Juan Basin Authority was formed in 1963 by four agencies: City of San Juan Capistrano, South Coast Water District, Santa Margarita Water District and Moulton Niguel Water District. The SJBA was formed to resolve water rights and to develop the water resources of the Lower San Juan Basin. It holds a water right in the amount of 10,702 afy that is partially assigned to the City of San Juan Capistrano for its groundwater recovery plant.

The community of San Juan Capistrano is the second oldest city in California, established with the construction of Mission San Juan Capistrano in 1776. The City has relied on surface and groundwater flows from that time. A number of wells have been constructed over the years in the lower basin (see following figure). The City has a water right of 3,325 afy under application to the SWRCB. South Coast Water District was originally formed in 1932 and was enlarged by subsequent consolidations. It holds a water right to San Juan Creek in the amount of 1,300 afy. Moulton Niguel Water District and Santa Margarita Water District were formed

under the California Water District act. Both agencies overlie the San Juan Basin but do not have groundwater resources or water rights except through the SJBA.

Description of Work

This study will investigate economic means for augmenting basin yield by increasing recovery of brackish/saline groundwater from the Lower San Juan Basin by expanded extraction/recovery, by conservation of stormwater by artificial recharge (spreading), and by reduction of water losses to increase yield by eradication of non-native phreatophytes (e.g., Arundo donax).

The SJBA agencies are looking to increase their current production level of 6,776 afy to 15,327 afy (total of existing water rights). The SOCOD Project is currently planned to pump about 32,000 afy from the planned slant beach intake wellfield, which would draw in about 1,600 afy of brackish groundwater and 30,400 afy of ocean water. Produced potable water from the plant would be about 16,000 afy.

Additional extraction of groundwater will induce infiltration of streamflows (stormwater and return flows of applied water) and recharge to the wells. Further measures will be needed to enhance groundwater yield by improved conservation of stormwater that is now lost to the ocean. Artificial recharge by instream and off-channel spreading are the most feasible spreading approaches, as new detention basins are not considered feasible.

In addition, the SOCOD Project offers the opportunity to salvage groundwater losses and to provide a seawater intrusion control barrier by the extraction trough that would be created by the slant beach well intake system. The SOCOD Project also provides the opportunity to recover about 50% of the upstream groundwater desalter brines that are now discharged to the ocean. These lower salinity brines can augment the ocean feedwater to the project. In addition, eradication and long-term control of invasive phreatophytes (e.g. Arundo donax) can conserve significant

surface and groundwater that is now consumed by these invasive plants as well as improving water quality, native habitat and fisheries.

Water Supply and Reliability

Since the 1950's, MWDOC in cooperation with south Orange County water agencies and Metropolitan Water District developed the imported water delivery system. Over the last decade MWDOC has been working on a wide range of water management programs to improve both supply and system reliability to the area.

Unlike north Orange County which has a large groundwater basin, the south Orange County area has very limited local groundwater and has had to heavily rely on imported water to meet its needs. In addition to significant water use efficiency programs, the area has also developed large scale recycled water landscape irrigation supplies, which are projected to reach 20 percent of total demand by 2020.

Out of the six south Orange County agencies, three rely 100% on imported water and two agencies rely 94% and 89% on imported water to meet their potable needs. The City of San Juan Capistrano which overlies the lower San Juan Basin area and has developed this brackish groundwater supply with the San Juan Basin Authority relies on the imported system to meet approximately 40% of its while its groundwater recovery plant can now meet approximately 60% of its potable needs.

Catastrophic interruptions to the imported water system from major earthquakes and floods can cause outages up to one year or more and represents a significant threat to the public health and safety as well as to the economy of the area. Significant effort has been underway to improve system reliability and to optimize development of local water supply. In 2004, MWDOC in cooperation with the South Orange County agencies prepared and adopted the "South Orange County Water Reliability Study Phase 2 System Reliability Plan". This plan recommended the implementation of major emergency interconnections, a 750 AF emergency storage

reservoir, a new potable water treatment plant to allow access to Irvine Lake stored water, expanded development of the San Juan Basin groundwater basin, and development of an ocean desalination project. To date, a major emergency interconnection (30 cfs) with the Irvine Ranch Water District and the Upper Chiquita Reservoir (750 af) have been constructed. Construction of the 28 mgd Baker Treatment Plant will be started later this year. Feasibility work on the South Orange Coastal Ocean Desalination (SOCOD) Project has been underway since 2004 with an elected officials project participants committee overseeing its development.

The following table shows total demand, recycled use, potable demand, potable groundwater, required imported water and percent dependence on imported water.

South Coastal Area Net Water Demands and Supplies After WUE Programs, Acre-Feet Projection for Year 2020

Water Supplier	Total Water Demand	Recycled Water Usage	**Potable Water Demand**	Potable Ground Water	**Required Imported Water**	Depend-ence on Import
Laguna Beach CWD	4,420	200	4,220	-	4,220	100%
Moulton Niguel WD	38,000	8,700	29,300	-	29,300	100%
San Clemente	10,840	1,830	9,010	500	8,510	94%
San Juan Capistrano	9,650	1,950	7,700	4,800	2,900	38%
Santa Margarita WD	43,991	9,603	34,388	116	34,272	100%
South Coast WD	8,495	1,200	7,295	800	6,495	89%
Total	115,396	23,483	91,913	6,216	85,697	93%

South Orange County Water Reliability Program

MWDOC with the assistance of South Orange County agencies prepared and adopted the *"South Orange County Water Reliability Study, System Reliability Plan"*

in 2003/04. This plan led to the development and construction of emergency water supply facilities by joint efforts of several of the SOC agencies. The goal of this initial effort was to provide about two weeks of water supply that would enable the agencies to sustain interruptions during planned system outages of the imported water system and emergency outages of short duration/magnitude.

Significant progress has been achieved with construction of two major facilities that were recommended in this plan: Upper Chiquita Emergency Storage Reservoir (750 AF) and the Irvine Ranch Water District Regional Emergency Supply Interconnection.

Currently under final design is the Baker Water Treatment Plant that would utilize the Baker Aqueduct, an untreated delivery pipeline from the Metropolitan Water District Lower Feeder. This pipeline can also draw water from Irvine Lake and will provide significant emergency storage to the area during periods of emergency outages to the imported system. This project has a plant capacity of 28 mgd (43.5 cfs) and average yield of 28,345 afy with 21,500 afy to be delivered to the South County Pipeline.

These three major emergency supply projects have greatly improved south Orange County's ability to sustain short-term supply disruptions. Additional supply is still required to be developed to more fully protect the area from longer periods of imported supply system outages and shortages. Two key supply projects that will help to improve both supply and system reliability are the: South Orange Coastal Ocean Desalination Project and projects to be developed from the Lower San Juan Creek Groundwater Management Plan.

The work under this grant application is part of that process to improve both water system and supply reliability for the area. The studies proposed under this grant application follow from the GWMP and are integral to their implementation. As part of the long and continuing effort to improve local supply reliability, development of

the local brackish groundwater resource of lower San Juan Creek has been an ongoing effort for several years.

Development of the full potential of the lower basin for potable water supply and local supply reliability has been a key and important long-term objective of the local agencies and MWDOC.

South Orange Coastal Ocean Desalination Project (SOCOD Project)

Over the past several years, MWDOC has been working with five south Orange County agencies (South Coast Water District, City of San Juan Capistrano, Moulton Niguel Water District, City of San Clemente and the Laguna Beach County Water District) in the development of the SOCOD Project.

A key part of the project work is the ongoing investigation into the use of slant beach intake wells to produce saline groundwater from the marine aquifer extension of the San Juan Creek alluvial channel. This channel extends for a few miles offshore within the continental shelf. The use of slant wells provides multiple benefits: development of new, drought proof and reliable potable water supply, improved water quality, conservation of groundwater losses to the ocean, opportunities for recovery of groundwater desalter brines through blending with the SOCOD Project slant well feedwater supply, and development of a pumping extraction trough covering the width of the San Juan Creek alluvial channel to provide an effective barrier for seawater intrusion control. The project has the potential to improve both supply and system reliability.

The feasibility work for this project began in 2002/03. It was determined early in the development work that the most economic and environmental protective approach for this project (lowest capital, operation and life cycle costs) is to pump ocean water by tapping into the marine aquifer with some type of subsurface intake. The alternative to a subsurface intake is a conventional open water column screened

intake. In this location, conventional intakes would need to extend about 6000 feet or more offshore due to the relatively flat continental shelf. An adequate water column depth of at least 55 feet is required for protection of the riser from major storms and wave surges. This approach was found to be economically infeasible for the project and could have significant environmental issues. Moreover, the use of a subsurface intake has received favorable support from environmental organizations and regulatory agencies.

To determine the feasibility of a subsurface intake system it was determined that a phased investigation was the best course of action. An initial onshore hydrogeology investigation was conducted in the winter/spring of 2005 with the drilling of four beach boreholes and completion of two into nested monitoring wells. Results showed that the alluvial formation along the San Juan Valley at the coastline were over 188 feet thick and were highly permeable. The alluvial aquifer along the coastline is about 2,500 feet wide.

Based on the favorable hydrogeology, an extensive review of groundwater extraction technologies was conducted to determine the most cost-effective method for use in this location. Studies evaluated infiltration galleries, vertical wells, radial/collector wells, horizontal directionally drilled water wells, and dual rotary slant wells. Based on this work, a decision was made to design and construct a test slant beach well using the dual rotary drilling method.

The wellhead was located on and drilled from Doheny State Beach out under the ocean in spring 2006. The Test Slant Well was successfully completed as a 12-inch diameter cased/screened gravel packed well that extends 350 feet out under the ocean at an angle of 23° from horizontal to the base of the main aquifer. The well was screened 220 feet in the main aquifer from 50 feet below the seafloor along the coast to 140 feet depth below the ocean floor at the end of the well. An extensive 4 foot thick clay layer occurs from a depth of minus 13 feet and is overlain by a shallow aquifer that is in direct continuity with the stream and ocean. The test slant

well was pump tested in 2006 for 7 days using conventional aquifer pumping test procedures; data loggers in the nested monitoring wells provided continuous water level data that were used in the analysis of the aquifer properties. The specific capacity of the well tested out at 70 gpm/foot of drawdown.

After the construction and testing of the Test Slant Well, a preliminary groundwater flow and variable density solute transport model was constructed that covered the Lower San Juan Basin. The USGS SEAWAT model was used for this purpose. It combines both the MODFLOW and MT3DMS codes for this application. Several other modules were also used in the modeling, including a lithologic model and stream channel network routing model. This initial modeling work indicated that a slant well field, consisting of nine wells in three clusters of three wells could produce 30 mgd with 7 wells operating and the other two wells in rotational standby mode. This is necessary to protect against a pump problem during the summer recreational season when access is not allowed.

This modeling work also showed that the well field would produce about 95% ocean water through the offshore marine aquifer and about 5% brackish water from inland sources, closely matching the Ghyben-Herzberg density relation for seawater intrusion. The water balance and modeling results indicated that subsurface discharge and rising groundwater outflow to the ocean exceeded 3,500 afy for basin, pumping and hydrologic conditions at that time. The slant well field would salvage a large portion of the groundwater losses to the ocean.

The modeling also showed that with the wellfield placed across the mouth of the alluvial channel in the three well clusters would also provide an effective seawater intrusion control barrier through the pumping trough. Further analysis is required to refine these preliminary estimates. The new, focused groundwater flow and variable density model will be used for this analysis.

Since the initial pumping test was only conducted for a short period and only was able to pull in brackish groundwater but showed increasing salinity, it was determined that a longer pumping test was necessary to more fully evaluate the feasibility of a slant wellfield. This work led to the Phase 3 Extended Pumping and Pilot Plant Test which was developed in 2007/08 with an MOU entered into between the five participating agencies and MWDOC to set up, fund, and form the governing committee for the project.

Subsequently, the test facilities were planned, permitted, designed and then constructed in 2009/10 with test pumping start-up in June 2010. The test pumping was just concluded on May 3, 2012 and the test results are now being evaluated and final reports are under preparation.

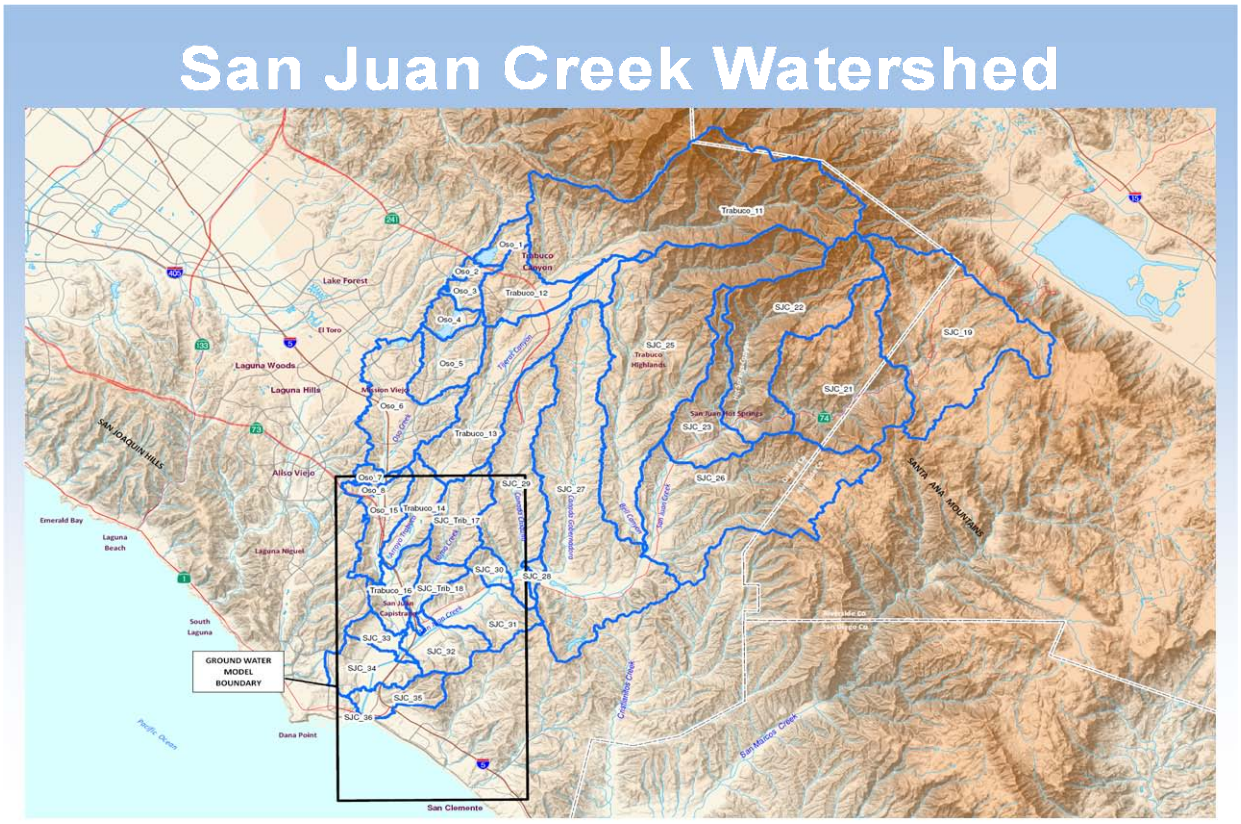
The groundwater modeling work is currently underway, with the surface water model and historical groundwater model calibration now completed. Various scenarios will now be run to evaluate basin yield over the 65 year 1946/47 – 2010/11 hydrology.

The Phase 3 investigation included several objectives:

- Observing the aquifer response under sufficient stress and duration,
- Assessing the performance of a special designed submersible pump,
- Testing various metals for corrosion for material selection,
- Measuring and observing biofouling growth and potential,
- Testing and evaluating pumped water quality and source water quality,
- Measuring the performance of the aquifer to provide conventional filtration,
- Conducting pretreatment and RO testing,
- Development of a calibrated San Juan Basin surface/groundwater flow model,
- Development of focused variable density coastal groundwater model, and
- Analyzing groundwater drawdown impacts

San Juan Creek Watershed and the Lower San Juan Basin

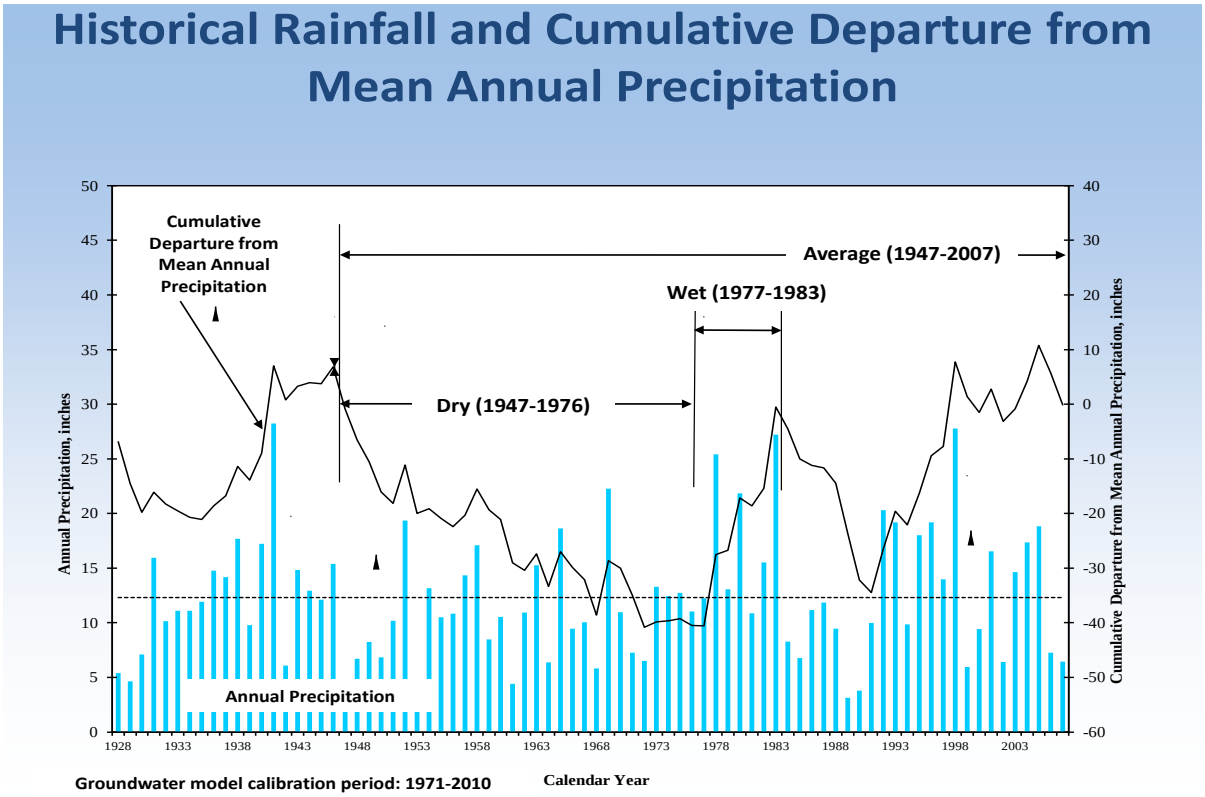
The San Juan Creek Watershed encompasses approximately 175 square miles (112,000 acres) with its highest point Saddleback Peak at 5,689 feet. The upper part of the watershed is situated within Cleveland National Forest. There are two principal streams that form the drainage basin: San Juan Creek and Arroyo Trabuco; Arroyo Trabuco is the main tributary to San Juan Creek in the lower basin. San Juan Creek has a drainage basin area of 121 square miles and Arroyo Trabuco has a drainage basin of 54 square miles. The Lower San Juan Basin starts just below Canada Chiquita where the Cristianitos Fault has constricted the cross section of the San Juan Creek alluvium. The following watershed map shows the entire watershed and Lower San Juan Basin model area.



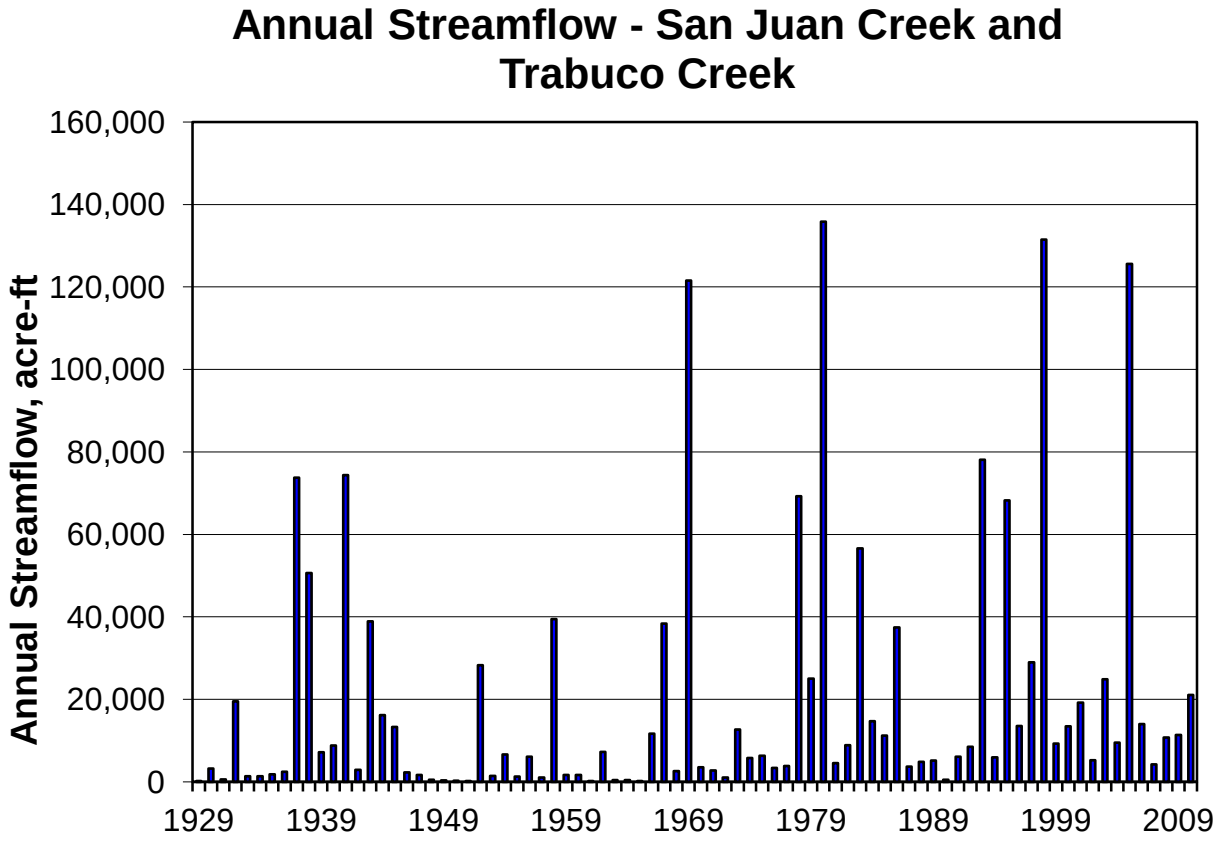
Marine sediments with soluble salts occur within the Arroyo Trabuco watershed and have yielded significant salt loads that have caused the natural groundwater quality in Arroyo Trabuco and the lower basin to be brackish. Total dissolved solids

concentrations range from 1,000 mg/l to 2,500 mg/l. The lower San Juan Basin (Arroyo Trabuco and San Juan Creek) is an alluvial filled stream cut valley that has an estimated maximum usable storage capacity of about 26,,600 acre-feet. This value has recently been updated and now shows a lower value than DWR's 1972 estimate of 40,000 af.

Precipitation principally falls as rain, with some snow accumulation in the highest elevations during cold, wet years. Most rainfall occurs during the winter months, with summers being typically dry. Annual rainfall amounts range from less than 5 inches in dry years and up to 30 inches in very wet years. Precipitation can be highly variable and historical dry periods can occur over decades. The nearest long-term precipitation station is in Laguna Beach, a few miles to the west of the watershed. The following figure shows for this station the annual rainfall from 1928 to 2010 with cumulative departure from means. The average for the period of record was 12.3 inches.



Streamflow has been gauged by the USGS since 1929 on Arroyo Trabuco and San Juan Creek just upstream from their confluence in the City of San Juan Capistrano. Over this period, the mean annual discharge of the combined flows of the two tributaries was 25,600 afy, with the minimum annual at 170 afy and the maximum annual at 135,850 afy. The gauged streamflow data indicates substantial flow over the period of record, with most of the water discharged to the ocean over the course of a storm event. A goal of this study is to identify feasible approaches to increase the conservation of this water through spreading operations and expanded groundwater extraction. The following figure shows the combined annual flows for the period of record.



Southern Steelhead Recovery

After World War II, southern California experienced rapid growth and development which led to significant alteration and changes to coastal streams, including construction of flood control dams and channelization, railroad and interstate highway bridges (often with control structures in the stream channel that created barriers to upstream fish migration), water quality degradation due to waste disposition and urban runoff, introduction of exotic and invasive species, etc. Also, from 1946 to 1977, southern California experienced a long-dry period which caused many of the smaller streams to remain mostly dry for many years. The multi-decadal overlap of rapid urbanization and drought are considered the primary factors that led to the significant loss in southern Steelhead population.

Due to the extended periods of drought throughout their range, especially in southern California, southern Steelhead are primarily active during periods of increased rainfall, such as El Nino years.

The migration of southern Steelhead from the ocean to upstream spawning grounds is a critical component in their life-cycle. When favorable flow conditions exist and the sand berms that seasonally close off the coastal lagoons have been breached, adult steelhead can then move upstream. Both upstream and downstream migrating fish have likely developed migration behavior that coincides with the relatively short duration peak flows common to southern California streams.

The migration window, which is highly variable between years, is dependent upon hydrologic connectivity between the ocean, lagoon/estuary, lower mainstream, and upper tributaries. In Southern California, this generally occurs following sizable rainfall events. Fish movements both upstream and downstream coincide with flow pulses from storms. These coastal streams are characterized by sand bar build up during low flow periods, especially during the summer months along their mouth. This is very much the case for San Juan Creek. During wetter years with periods of longer and deeper stream flows, steelhead would have the potential to successfully migrate up to spawning areas

in the higher mountainous areas where riparian habitat and gravel beds and pools occur. Actual sighting of steelhead in lower San Juan Creek in recent years has been very rare, with only two adults observed attempting to migrate upstream in the last 8 years.

The literature indicates that adult steelhead require a minimum depth of about 7.5" of streamflow to enable upstream migration. For the southern Steelhead along the south Orange County and San Diego stream systems, the drier and more pronounced intermittent character of these streams results in adult fish staying in the ocean for up to several years before conditions occur that are favorable for spawning. In these cases, the adult steelhead are larger fish and thus require a greater depth of flow, perhaps 8 to 9-inches to successfully reach the higher elevation spawning areas.

The National Marine Fishery Service (NMFS) has been in the process of working on plans for the recovery of the southern Steelhead for several years. They recently released their final Recovery Plan for the southern Steelhead for southern California coastal streams in January 2012. In addition, Trout Unlimited has been working with the California Wildlife Conservation Board for the past several years on efforts to help in the recovery of southern Steelhead in San Juan Creek through the design of fish ladders/resting pools along Arroyo Trabuco. This project has not yet been constructed.

The surface model element has been calibrated against streamflow gauged data for both San Juan Creek and Arroyo Trabuco. This model can simulate daily flows and it includes channel geometry. A slight modification to this model can be made to allow determination of depth of flows along Arroyo Trabuco and San Juan Creek within the lower basin. This study would modify the model and then use it to estimate periods available for steelhead migration and spreading operations. Flow duration and frequency curves can be developed for recessional flows for a given depth of flow to determine the potential yield along different reaches that could be used for spreading operations.

Lower San Juan Basin Water Management, Water Rights, and Development

The SJBA developed and adopted its initial San Juan Basin Groundwater Management and Facility Plan in 1994; this plan led to the development, implementation and construction of the San Juan Ground Water Recovery Plant in 2005. Subsequently, in 1998 the SJBA authorized the preparation of a study entitled *"Availability of Unappropriated Water in the San Juan Creek Basin"* that was prepared by Stetson Engineers & Boyle Engineering Corporation. It was used to support water rights applications submitted to the SWRCB by the SJBA, SCWD and the City and to develop the final basis for the aforementioned groundwater recovery project. This study concluded that unappropriated water amounted to 11,100 afy and estimated an increase at build out to 14,100 afy. These estimates were based on a repeat of the hydrology that occurred over the period 1969/70 to 1991/92.

These yields are now being further evaluated through the joint effort by MWDOC and SJBA through extensive surface/groundwater modeling as part of the GWMP update. This new work will examine the variation in basin yield over a longer period of record that includes the extended 31 year dry period from 1947 through 1977.

The SWRCB granted Water Rights Permit No. 21074 to the SJBA on October 30, 2000 for diversion and use of San Juan Creek water at the maximum rate of 17.3 cfs and in the annual amount of 8,026 afy with a right to increase this amount upon availability of unappropriated water and approval by the SWRCB to 10,702 afy. The granting of the water right cleared the way for the development of the San Juan Capistrano Ground Water Recovery Plant which became operational in 2005. This facility has a current feedwater capacity of 5,800 afy of brackish groundwater that yields about 4,800 afy of potable water. The treatment train includes iron and manganese removal, reverse osmosis desalination, GAC for organics removal, and disinfection.

Following the above action, the SWRCB granted Water Rights Permit No. 21138 on December 19, 2002 to the South Coast Water District for diversion and use of San Juan Creek water at the maximum rate of 4 cfs and in the annual amount of 976 afy with a right to increase this amount upon showing of the availability of unappropriated water and approval by the SWRCB to 1,300 afy. The South Coast Water District then constructed its groundwater recovery facility in 2005. This project has a feedwater capacity of about 976 afy that produces about 800 afy of potable water. The treatment train includes iron and manganese removal on the bypass and brackish reverse osmosis desalination, and disinfection.

Both agencies plan to increase the capacity of their desalters so as to fully utilize their water rights; they have installed new wells or are in the process of doing so.

Subsequent to the construction of both groundwater recovery plants in 2005, the SJBA authorized the preparation of the "*San Juan Basin Conjunctive Use Project Feasibility Study*" by PSOMAS (January 2006). This study investigated a new groundwater recovery plant, several potential in-stream recharge sites, and the Gavian Flood Detention Basin in Arroyo Trabuco as a possible spreading basin. This study recommended that further investigation was necessary to more fully evaluate the potential recharge capacity and environmental implementation requirements for these potential projects. They recommended that tasks that need to be completed before final site selection would include:

- Site entry and land use arrangements for field testing
- Geotechnical borings
- Soil infiltration and percolation tests
- Aquifer pumping tests to determine aquifer properties
- Water quality investigation
- Stream gauging to establish baseflow conditions
- Stormflow studies to determine scouring and sedimentation rates

- Biological surveys for environmental impact and mitigation work to support CEQA and permits

This grant application includes tasks to expand upon the in-stream spreading concept work done in this study.

As part of SJBAs management activities, SJBA retains the USGS to maintain two streamflow gauging stations, maintains a system of monitoring wells, collects groundwater production data, collects water level data and conducts vegetation monitoring. These data are summarized in the annual report submitted to the SWRCB Division of Water Rights.

The collection of hydrogeological data including static water level measurements in pumping wells and monitoring wells is a requirement of the Water Rights permits. SJBA as the designated monitoring entity is also conducting this work in full compliance with the CASGEM program. This data is used to calculate the amount of groundwater in storage in various segments of the groundwater basin. If the pumping results in a drawdown of 50% of the storage capacity, the SWRCB has the authority to order a cessation of pumping to avoid overdrafting of the Basin. Water Quality data is also collected in order to evaluate any adverse conditions that may have developed.

Vegetation monitoring is also an ongoing program conducted pursuant to the Water Rights permits to assess the effect of groundwater pumping on native vegetation along San Juan creek. Special observation stations are located at key locations along the creek and routine observations are made by a qualified biologist to determine the health of the vegetation during the different seasons of the year. General botanical observations including species composition, amount of leaf yellowing, leaf drop and general wildlife observations.

The annual monitoring report includes the following data:

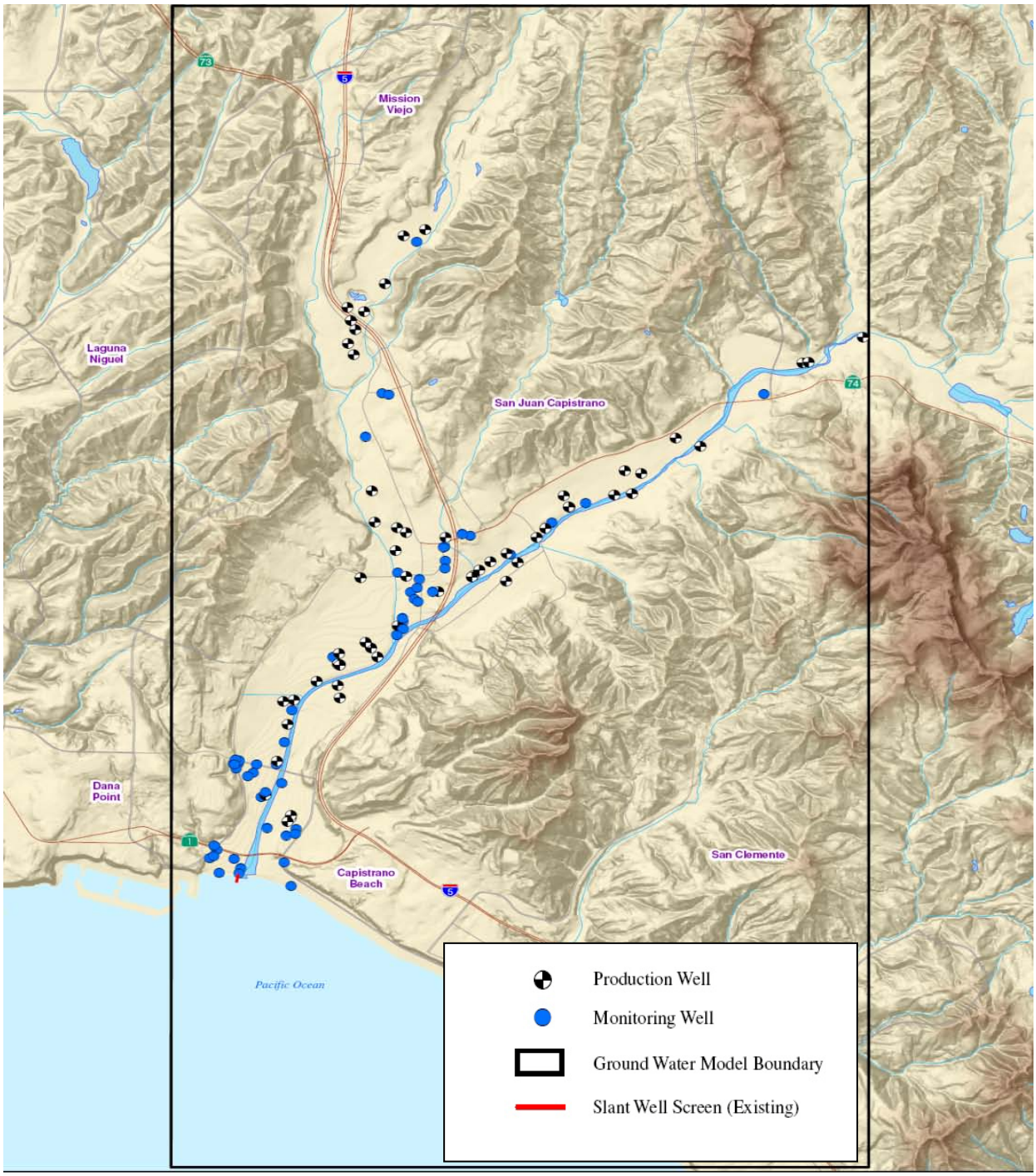
- Monthly surface water and biotic conditions
    - Streamflow gauging data (flow at two stations maintained by USGS)
    - Field water quality and flow conditions
    - Vegetation monitoring
- Monthly groundwater conditions
    - Groundwater levels
    - Field water quality sampling/analyses
- Bi-annual laboratory analysis
    - Groundwater monitoring wells water quality
    - Plant monitoring stations
- Calculations/plots of monthly and cumulative change in groundwater storage

The Lower San Juan Basin network of groundwater monitoring wells extends from the shoreline to the upper reaches; the network is maintained by SJBA, SCWD and MWDOC. SJBA manages the overall data set. This valuable groundwater monitoring data base has been key in the groundwater model calibration work. The monitoring well network will be used in ongoing groundwater basin monitoring and management operations. A review of the monitoring well network will be made to determine if significant data gaps exist and if new monitoring wells would be necessary for basin management purposes. The following figure shows all wells in the Lower San Juan Basin.

The County of Orange, Orange County Watersheds group is the lead for the Integrated Regional Watershed Management Plan for the San Juan Basin. MWDOC has a representative on the Executive Committee and Management Committee. One area of work that is currently underway is the *"Flood Plain Management Plan"*, which is scheduled to be adopted in October 2013 after final approval by Orange County Watersheds and MWDOC. An element of this plan will be the potential use of in-stream areas for enhanced groundwater recharge through the use of artificial recharge operations.

WELL LOCATIONS

LOWER SAN JUAN BASIN



What remains to be accomplished in the basin are several management activities and projects:

(1) Increase brackish/saline groundwater recovery.
(2) Develop effective programs to improve the conservation and recharge of stormwater flows that are now lost to the ocean.
(3) Evaluate the feasibility to improve recovery of groundwater storage during extended dry periods by use of Radial/Collector Wells.
(4) A sustainable plan for long-term eradication and control of non-native phreatophytes (e.g., Arundo donax) to curtail intensive water losses, salt concentrating effects, native habitat destruction, and creation of fire hazards.
(5) Evaluate the salvage of groundwater losses to the ocean and seawater intrusion control protection through installation of a extraction barrier along the coast to protect the basin, especially during periods of extended drought.
(6) Evaluate the feasibility for the recovery of brines from groundwater desalters,
(7) Coordination with NMFS and other resource agency programs to review plans for recovery of southern Steelhead, habitat restoration, and migration flow criteria, and the water agencies plans for enhanced water supply and how both objectives can be achieved.

This grant application is directed to advance the above items for enhancing groundwater yield in the Lower San Juan Basin.

Summary

This proposed study is a key element in the continued efforts to achieve the management goal of enhancing groundwater yield. It follows as part of the implementation of the current Groundwater Management and Facility Plan (May 1994) and Conjunctive Use Study (2006); the Groundwater Management Plan is being updated at this time and is expected to be completed by the end of this year. The timing for this Local Groundwater Assistance grant round in early 2013 fits well

with the work currently underway, including the calibration of a comprehensive surface/groundwater flow and solute transport model that has been under development for two years and is scheduled to be fully calibrated and completed this fall.